



Single Taxon Treatment

# A new western Canadian record of *Epeoloides pilosulus* (Cresson), with discussion of ecological associations, distribution and conservation status in Canada

Cory S. Sheffield<sup>‡</sup>, Jennifer Heron<sup>§</sup>

<sup>‡</sup> Royal Saskatchewan Museum, Regina, Canada

<sup>§</sup> British Columbia Ministry of Environment and Climate Change Strategy, Species Conservation Science Unit, Vancouver, Canada

Corresponding author: Cory S. Sheffield ([cory.sheffield@gov.sk.ca](mailto:cory.sheffield@gov.sk.ca))

Academic editor: Matthew Yoder

Received: 07 Dec 2017 | Accepted: 02 Apr 2018 | Published: 13 Apr 2018

Citation: Sheffield C, Heron J ( ) A new western Canadian record of *Epeoloides pilosulus*(Cresson), with discussion of ecological associations, distribution, and conservation status in Canada. . <https://doi.org/>

## Abstract

### Background

*Epeoloides pilosulus*, one of the rarest bees in North America, is a cleptoparasite of *Macropis* bees which themselves are uncommon oligoleges of oil-producing *Lysimachia* flowers. Only two specimens of the cleptoparasite have been reported from Canada since the 1960s, both from Nova Scotia.

### New information

A recently collected specimen of *Epeoloides pilosulus* from Alberta, Canada confirms this species from that province and greatly increases its known range in western North America. This record and additional specimens from southern Ontario (one collected in

1978) have implications for the conservation status of this COSEWIC assessed species in Canada, which are discussed.

## Keywords

oil bee, oligolege, *Macropis* Cuckoo Bee, COSEWIC

## Introduction

*Epeoloides pilosulus* (Cresson) (aka *Macropis* Cuckoo Bee - COSEWIC 2011) is one of the rarest bees in North America. The earliest records in Canada date from at least 1888 (Provancher 1888 and see Sheffield and Perron 2014) and, up to the most recent published accounts of this species in Canada (Sheffield et al. 2004, COSEWIC 2011), there have been only 12 specimens recorded from the country. In the last 60 years, only a handful of specimens have been collected in North America (Sheffield et al. 2004, Wagner and Ascher 2008), with the most recent collection event being a single specimen from Huyck Preserve in Albany County, New York State on July 8, 2014 (<http://bugguide.net/node/view/954741>) (see Gibbs et al. 2017).

*Epeoloides pilosulus* is a member of one of the most tenuous ecological existences seen in North American plant-pollinator relationships, being a cuckoo (=cleptoparasite) of and thus, dependent on *Macropis* bees (Melittidae) which in turn are uncommon oligoleges of oil-producing *Lysimachia* species (Primulaceae, Myrsinoideae) (Sheffield et al. 2004, Wagner and Ascher 2008, Alves-dos-Santos 2009) (Fig. 1).



Figure 1. [doi](#)

*Macropis nuda* (Melittidae) on oil-producing flowers of *Lysimachia terrestris* (Linnaeus) (Primulaceae) near Middleton, Nova Scotia, Canada. Photo by C.S. Sheffield.

*Epeoloides pilosulus* is one of only two globally recognised species in the genus (Michener 2007), the other, *E. coecutiens* (Fabricius), which was studied in detail by Straka and Bogusch (2007b) is found in Europe (Popov 1958, Pekkarinen et al. 2003, Bogusch 2005, Michez and Patiny 2005, Dötterl and Schächler 2006). Interestingly, these two species are presently considered members of the tribe Osiriini, a taxon otherwise restricted to the Neotropics (Michener 2007), though others have indicated that *Epeoloides* may have affiliations to other tribes in the Apidae (Straka and Bogusch 2007a, Cardinal et al. 2010). However, the known hosts of *Epeoloides* (i.e. *Macropis* bees) and their host plants (genus *Lysimachia*) have centres of diversity elsewhere (Michez and Patiny 2005, Michener 2007). In fact, both *Macropis* (Michez and Patiny 2005) and *Lysimachia* (Chen and Hu 1979, Zhang et al. 2006, Zhou et al. 2015) are most diverse in China; eight of the 16 *Macropis* species and 138 of the ca. 180 known plant species occurring there (Michez and Patiny 2005, Zhang et al. 2006), though *Lysimachia* also occurs in areas where neither genus of bee has been recorded (Marr and Bohm 1997). However, not all species of *Lysimachia* are oil-producing and, of the five recognised subgenera, only two contain species with oil-producing flowers that are co-occurring with *Macropis* bees (Michez and Patiny 2005). Michez and Patiny (2005) provide a detailed account of the biogeography of *Macropis* bees and *Lysimachia* hosts. Strangely, *Epeoloides* is seemingly absent from the centres of diversity of both *Macropis* bees and *Lysimachia* floral hosts (Michener 2007).

The purpose of this paper is to report on a recently collected specimen of *E. pilosulus* from Alberta, Canada which significantly increases the range of this species in western North America and additional specimens in the collections at the Royal Saskatchewan Museum and the University of Guelph. We also comment on its conservation status in Canada.

## Materials and methods

Data from *Epeoloides pilosulus* specimens known from Canada were previously compiled for the conservation assessment for the Committee On the Status of Endangered Wildlife in Canada (COSEWIC) in 2011 (COSEWIC 2011). Data from that report were combined with previously unrecorded Canadian records not available or known at that time, including material collected in a Malaise trap as part of efforts to collect material within Canada's National Parks for DNA barcoding, a single specimen from Saskatchewan within the entomology collection at the Royal Saskatchewan Museum and two specimens (collected in 1915 and 1978) in the entomology collection at the University of Guelph.

## Data resources

The full dataset for *Epeoloides* and *Macropis* specimens that were used in this study is archived with Canadensys (<http://community.canadensys.net/>) under resource title “A new western Canadian record of *Epeoloides pilosulus* (Cresson)” and can be accessed using the following: doi: <https://doi.org/10.5886/vfi8nn>.

## Taxon treatment

### *Epeoloides pilosulus* (Cresson, 1878)

#### Nomenclature

*Nomada pilosula* Cresson 1878: 77 [♂]

*Nomia compacta* Provancher 1888: 337 [♂] [synonymy by Mitchell (1962)]

*Epeolus pilosulus* Provancher 1888: 426 [♀] [synonymy by Mitchell (1962)]

*Viereckella obscura* Swenk 1907: 299 [♀] [synonymy by C.D. Michener, as cited in Sheffield et al. (2004) and see Michener (2000)]

*Viereckella ceanothina* Cockerell, in Swenk 1907: 300 [♂] [synonymy of *V. obscura* by Swenk (1912)]

*Epeoloides nearcticus* Ducke 1909: 39 [♀] [synonymy by Bequaert (1920)]

#### Materials

##### Other materials:

- a. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Saskatchewan; locality: Wood Mountain; decimalLatitude: 49.316; decimalLongitude: -106.38; year: 1955; month: 8; day: 5; individualCount: 1; sex: female; lifeStage: adult; catalogNumber: CNC\_Epeoloides\_pilosulus\_1; recordedBy: A.R. Brooks; identifiedBy: T. Romankova; dateIdentified: 2001; collectionCode: Insects; ownerInstitutionCode: CNC; basisOfRecord: PreservedSpecimen
- b. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Manitoba; locality: Aweme; decimalLatitude: 49.7; decimalLongitude: -99.6; year: 1919; month: 7; day: 13; individualCount: 1; lifeStage: adult; catalogNumber: CNC\_Epeoloides\_pilosulus\_2; recordedBy: F.W.L. Sladen; identifiedBy: T. Romankova; dateIdentified: 2001; collectionCode: Insects; ownerInstitutionCode: CNC; basisOfRecord: PreservedSpecimen
- c. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Ontario; locality: One Sided Lake; decimalLatitude: 49.0602778; decimalLongitude: -93.8947223; year: 1960; month: 7; day: 24; individualCount: 1; lifeStage: adult; catalogNumber: CNC\_Epeoloides\_pilosulus\_3; recordedBy: S.M. Clark; identifiedBy: T. Griswold; collectionCode: Insects; ownerInstitutionCode: CNC; basisOfRecord: PreservedSpecimen
- d. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee;

- genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Québec; locality: Aylmer; decimalLatitude: 45.39; decimalLongitude: -75.84; year: 1915; month: 6; day: 21; individualCount: 1; lifeStage: adult; catalogNumber: CNC\_Epeoloides\_pilosulus\_4; recordedBy: F.W.L. Sladen; identifiedBy: H.L. Viereck; collectionCode: Insects; ownerInstitutionCode: CNC; basisOfRecord: PreservedSpecimen
- e. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Manitoba; locality: Aweme; decimalLatitude: 49.7; decimalLongitude: -99.6; year: 1924; month: 7; day: 6; individualCount: 1; lifeStage: adult; catalogNumber: JBWM0296405; recordedBy: R.D. Bird; identifiedBy: H.L. Viereck; collectionCode: Insects; ownerInstitutionCode: Wallis-Roughley Museum of Entomology; basisOfRecord: PreservedSpecimen
- f. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Saskatchewan; locality: Wallwort; decimalLatitude: 52.5; decimalLongitude: -104.04; year: 1942; month: 7; day: 16; individualCount: 1; lifeStage: adult; catalogNumber: 632961; recordedBy: J.D. Ritchie; identifiedBy: C.D. Michener; collectionCode: Insects; ownerInstitutionCode: Natural History Museum and Biodiversity Research Center, University of Kansas; basisOfRecord: PreservedSpecimen
- g. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Saskatchewan; locality: Wallwort; decimalLatitude: 52.5; decimalLongitude: -104.04; year: 1942; month: 7; day: 17; individualCount: 1; lifeStage: adult; catalogNumber: 632964; recordedBy: J.D. Ritchie; identifiedBy: C.D. Michener; collectionCode: Insects; ownerInstitutionCode: Natural History Museum and Biodiversity Research Center, University of Kansas; basisOfRecord: PreservedSpecimen
- h. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Saskatchewan; locality: Wallwort; decimalLatitude: 52.5; decimalLongitude: -104.04; year: 1942; month: 7; day: 20; individualCount: 1; lifeStage: adult; catalogNumber: 632958; recordedBy: J.D. Ritchie; identifiedBy: C.D. Michener; collectionCode: Insects; ownerInstitutionCode: Natural History Museum and Biodiversity Research Center, University of Kansas; basisOfRecord: PreservedSpecimen
- i. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Alberta; locality: Elk Island National Park, Hayburger Trail; decimalLatitude: 53.634; decimalLongitude: -112.857; year: 2010; month: 8; day: 11; individualCount: 1; lifeStage: adult; catalogNumber: BBHYK681-10; recordedBy: BIObus 2010; identifiedBy: J.K. Stahlhut; collectionCode: Insects; ownerInstitutionCode: University of Guelph, Centre for Biodiversity Genomics; basisOfRecord: PreservedSpecimen



- j. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Nova Scotia; locality: near Middleton; decimalLatitude: 44.9665; decimalLongitude: -65.056; year: 2002; month: 7; day: 17; individualCount: 1; sex: male; lifeStage: adult; catalogNumber: BEECB232-07; recordedBy: C.S. Sheffield; identifiedBy: C.S. Sheffield; dateIdentified: 2003; collectionCode: Insects; ownerInstitutionCode: University of Guelph, Centre for Biodiversity Genomics; basisOfRecord: PreservedSpecimen
- k. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Nova Scotia; locality: near Middleton; decimalLatitude: 44.9665; decimalLongitude: -65.056; year: 2002; month: 7; day: 11; individualCount: 1; sex: male; lifeStage: adult; catalogNumber: 632963; recordedBy: C.S. Sheffield; identifiedBy: C.S. Sheffield; dateIdentified: 2003; collectionCode: Insects; ownerInstitutionCode: Natural History Museum and Biodiversity Research Center, University of Kansas; basisOfRecord: PreservedSpecimen
- l. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Saskatchewan; locality: Wallwort; decimalLatitude: 52.5; decimalLongitude: -104.04; year: 1942; month: 7; day: 10; individualCount: 1; lifeStage: adult; catalogNumber: RSKM\_ENT\_E-81549; recordedBy: J.D. Ritchie; identifiedBy: C.S. Sheffield; dateIdentified: 2016; collectionCode: Insects; ownerInstitutionCode: RSKM; basisOfRecord: PreservedSpecimen
- m. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Ontario; locality: Simcoe; decimalLatitude: 42.83; decimalLongitude: -80.3; year: 1915; month: 7; day: 2; individualCount: 1; sex: male; lifeStage: adult; catalogNumber: debu01088907; recordedBy: G.J. Spencer; identifiedBy: R. Lambert; dateIdentified: 1952; collectionCode: Insects; ownerInstitutionCode: DEBU; basisOfRecord: PreservedSpecimen
- n. scientificName: *Epeoloides pilosulus*; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Ontario; locality: Milton; decimalLatitude: 43.51; decimalLongitude: -79.88; year: 1978; month: 7; day: 6; individualCount: 1; sex: female; lifeStage: adult; catalogNumber: debu01088908; recordedBy: D. Morris; identifiedBy: T. Romankova; collectionCode: Insects; ownerInstitutionCode: DEBU; basisOfRecord: PreservedSpecimen

*Lectotype:*

- a. scientificName: *Epeoloides pilosulus*; originalNameUsage: *Epeolus pilosulus* Provancher, 1888; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Québec; locality: Cap Rouge; decimalLatitude: 46.76; decimalLongitude: -71.35; individualCount: 1; sex: female; lifeStage: adult; catalogNumber: 1529 [yellow label]; recordedBy: L. Provancher; identifiedBy: L. Provancher; collectionCode: Insects; ownerInstitutionCode: The Provancher Collection, Université Laval, Ste Foy, Québec; basisOfRecord: PreservedSpecimen

*Holotype:*

- a. scientificName: *Epeoloides pilosulus*; originalNameUsage: *Nomia compacta* Provancher, 1888; kingdom: Animalia; phylum: Arthropoda; class: Insecta; order: Hymenoptera; family: Apidae; vernacularName: *Macropis* Cuckoo Bee; genus: *Epeoloides*; specificEpithet: *pilosulus*; scientificNameAuthorship: (Cresson, 1878); continent: North America; country: Canada; stateProvince: Québec; locality: Cap Rouge; decimalLatitude: 46.76; decimalLongitude: -71.35; individualCount: 1; sex: male; lifeStage: adult; catalogNumber: 1670 [yellow label]; recordedBy: L. Provancher; identifiedBy: L. Provancher; collectionCode: Insects; ownerInstitutionCode: The Provancher Collection, Université Laval, Ste Foy, Québec; basisOfRecord: PreservedSpecimen

**Conservation**

The species is assessed nationally as Endangered in Canada by COSEWIC (COSEWIC 2011), but has not been listed under the Canadian Species At Risk Act (SARA). The criteria COSEWIC uses to assess the status of species is adapted from the International Union for the Conservation of Nature (IUCN) Red-list categories (see COSEWIC 2012). *Epeoloides pilosulus* was assessed under the B criteria (i.e. meeting B2ab(iii) as the index of area of occupancy (4 km<sup>2</sup>, calculated only for the last ten year period of assessment) was below the threshold of 500 km<sup>2</sup>, the species had been found at only one location in the past 10 years, has always existed in fragmented populations and there is a continuing decline in suitable wetland habitat for the flowering plant species upon which the host cuckoo bee ultimately depends due to development, invasive species and reduction in wetland area) (COSEWIC 2011).

Each province and territory has separate legislation that protects species at risk in that jurisdiction. Though there are previous records of *Epeoloides pilosulus* from Nova Scotia, Quebec, Ontario, Manitoba and Saskatchewan, the species is only listed as a Species at Risk under the Nova Scotia Endangered Species Act (NESA 2013). The species was assessed as Data Deficient by the Committee on the Status of Species at Risk in Ontario (COSSARO) (COSSARO 2010).

Non-legal conservation status ranks have also been completed using NatureServe methodology and definitions (Master et al. 2012). The global rank is G1 (critically imperilled - because of extreme rarity [often 5 or fewer occurrences] or because of some factor(s) such as very steep declines making it especially vulnerable to extirpation from the state/province). The national rank for (Canada) is N1 (critically

imperilled), with provincial ranks for Nova Scotia (S1), Quebec (SNR, unranked - conservation status not yet assessed), Ontario (S1), Manitoba (S1) and Saskatchewan (S1) (CESCC 2016, Atlantic Conservation Data Centre 2017).

The four recent records from Alberta in 2010, Ontario in 1978 (both reported here) and Nova Scotia in 2002 (Sheffield et al. 2004) are the only specimens of this species collected in Canada since 1960.

## Analysis

Since the time of the COSEWIC assessment of this species for Canada (COSEWIC 2011), the new records from Alberta (Elk Island National Park) (Fig. 2) and southern Ontario increases the Extent of Occurrence (EOO) in Canada from ca. 0.91 million km<sup>2</sup> (204,490 km<sup>2</sup> was reported by COSEWIC 2011) to ca. 1.5 million km<sup>2</sup> and the Area of Occupancy (AO, based on 2 x 2 = 4 km<sup>2</sup> grids) from 24 km<sup>2</sup> to 160 km<sup>2</sup> (Fig. 3). As this species is dependent on and confined within the range of its host bees (*Macropis*) (Fig. 4; EOO of 1.9 million km<sup>2</sup> in Canada) which in turn are dependent on oil-producing species of *Lysimachia*, the range of suitable native host plants in Canada represents the possible range extent of the cuckoo bee, which is almost 5 million km<sup>2</sup> (Fig. 5); likely it is even greater considering that at least some species of *Lysimachia* occur in the Northwest Territories and Yukon (Porsild and Cody 1980, Cody 2000). However, *E. pilosulus* has not previously been recorded this far west in North America (Ascher and Pickering 2018); the genus was not even included in the key to bee genera of north-western North America (Stephen et al. 1969).



Figure 2. [doi](#)

The *Macropis* Cuckoo Bee, *Epeoloides pilosulus* (Cresson) (Apidae). Female, lateral view. Specimen from Alberta. Photo by R. Oram, Royal Saskatchewan Museum.



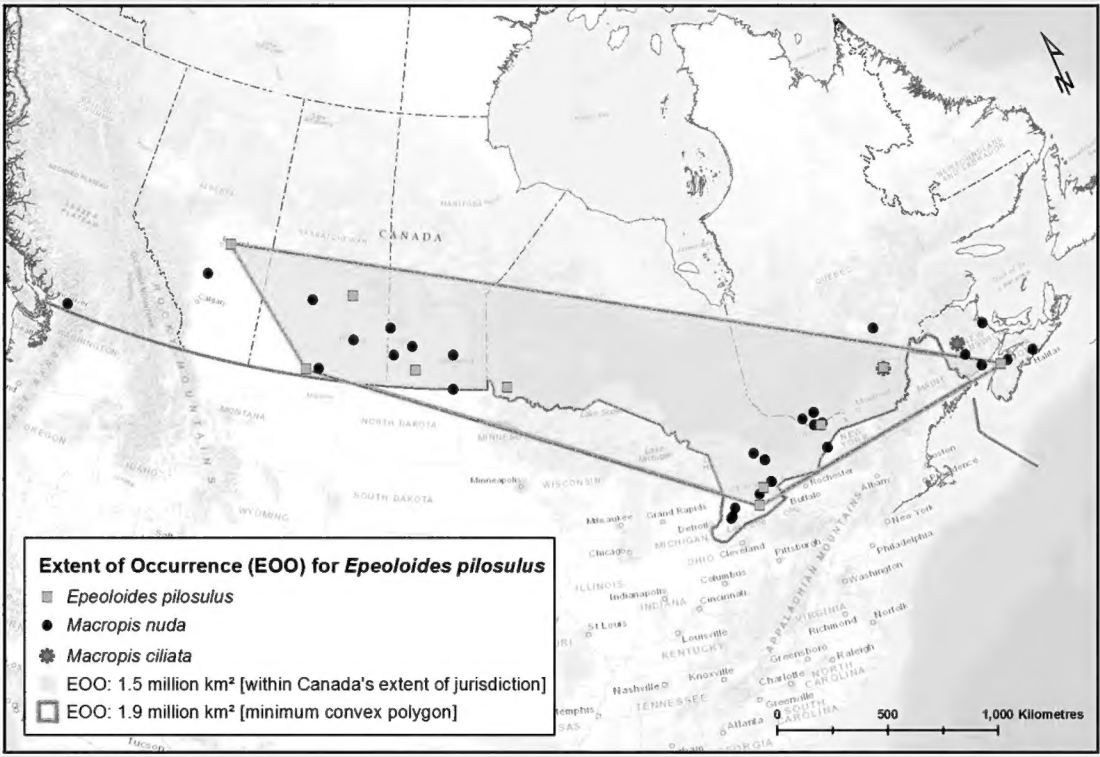


Figure 3. [doi](#)

The known Extent of Occurrence (EOO) of *Epeoloides pilosulus* (Cresson) (Apidae) within Canada's extent of jurisdiction (yellow area) and based on minimum convex polygon (within blue lines).

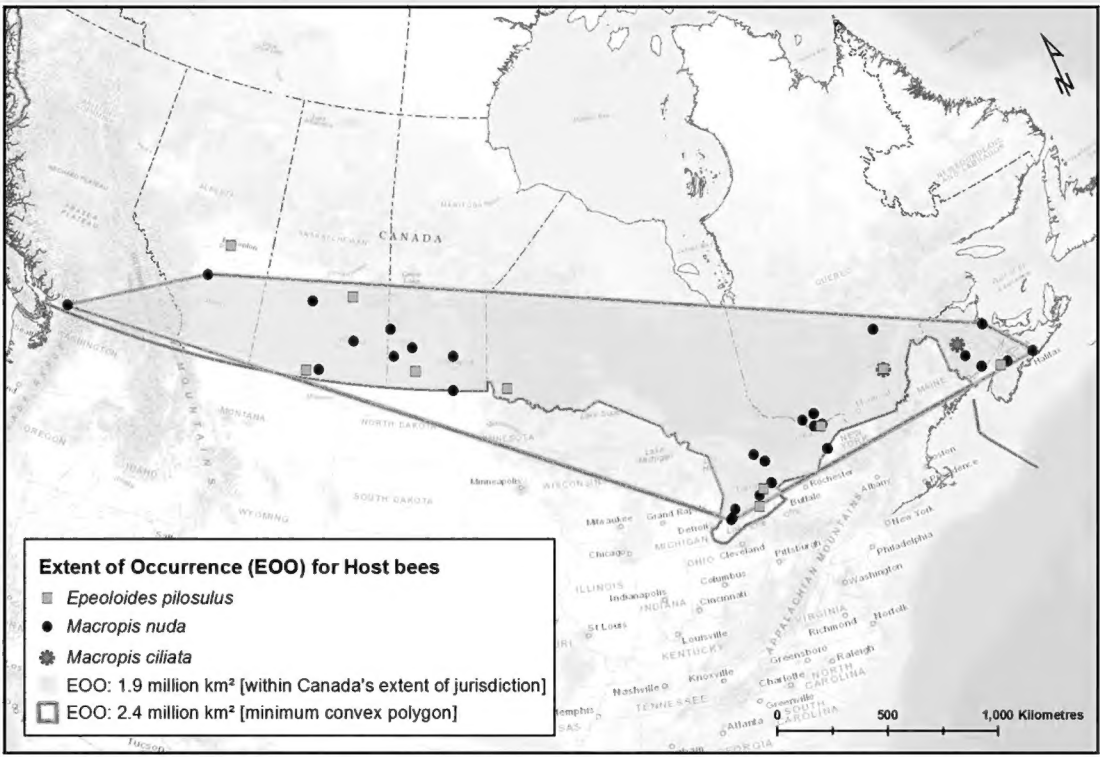


Figure 4. [doi](#)

The known Extent of Occurrence (EOO) of *Macropis* bees, *M. nuda* (Provancher), *M. ciliata* Patton (Melittidae) within Canada's extent of jurisdiction (yellow area) and based on minimum convex polygon (within blue lines). Data from the Canadian National Collection of Insects, Arachnids and Nematodes (CNC), the Royal Saskatchewan Museum (RSKM) and other sources (Suppl. material 1).

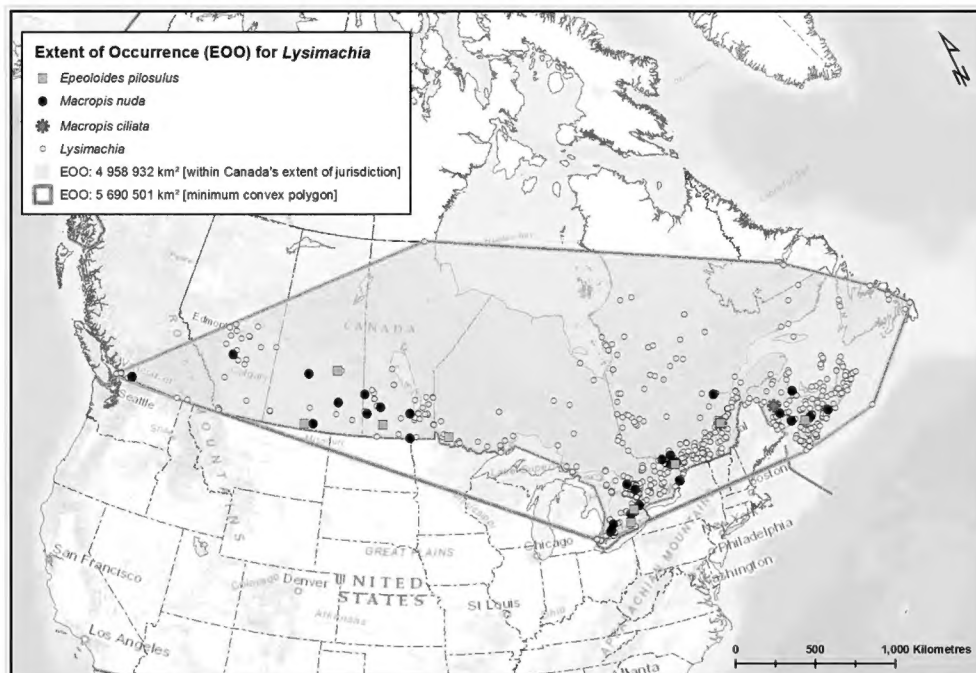


Figure 5. [doi](#)

Extent of Occurrence (EOO) of native oil-producing *Lysimachia* species (Primulaceae) in Canada. Figure produced using records obtained from GBIF for species listed in Table 1 (see GBIF 2018, and Suppl. material 2).

## Discussion

The newly recorded Canadian specimen of *E. pilosulus* greatly increases the recorded EOO of this species in Canada (Fig. 3) and for North America, being the furthest into the northwest that this species has been observed. Recently, but not suprisingly due to the presence of the host plant(s), the main *Macropis* host in Canada, *M. nuda* (Provancher), was photographed in south-central British Columbia (see Kline 2017), though specimens have been known from that province since 1914 (Fig. 4), suggesting that *E. pilosulus* may also be present in that province. The genus *Lysimachia* however is more widespread than either bee species in this triumvariate, with two species, *L. thyrsiflora* and *L. ciliata* occurring well into the north of Canada and Alaska (Table 1). Porsild and Cody (1980) recorded *L. thyrsiflora* from the Northwest Territories, but this species is a non-oil producer, so is likely not being used by *Macropis* bees as a source of oil. The other northerly distributed species, *L. ciliata* is an oil-producer (Fig. 6) and is used by *Macropis* bees in southern parts of the plants range, though neither this genus nor the cuckoo bee have been recorded that far north, suggesting that the bees, but not the plant, are dependants within these plant-pollinator (+ cuckoo) relationships. However, there are also six non-native *Lysimachia* species in North America, four of which are oil-producers (Table 1) and most of these are grown ornamentally (Fig. 7).

Table 1.

Species of *Lysimachia* in North America, showing their native status, oil production and notes on distribution. Compiled from data in Cody (2000), Coffey and Jones (1980), Estes et al. (2015), Porsild and Cody (1980), Ray (1956), USDA (2017).

<b><i>Lysimachia</i> Species</b>	<b>Subgenus</b>	<b>Native</b>	<b>Oil</b>	<b>Distribution</b>
<i>L. asperulifolia</i> Poir.	<i>Lysimachia</i>	yes	yes	Southeast USA
<i>L. barystachys</i> Bunge	<i>Palladia</i>	no	no	Southeast USA
<i>L. ciliata</i> L.	<i>Seleucia</i>	yes	yes	CAN, USA [incl. AK]
<i>L. clethroides</i> Duby	<i>Palladia</i>	no	no	Eastern CAN and USA
<i>L. × commixta</i> Fernald [ <i>terrestris</i> × <i>thyrsiflora</i> ]	<i>Lysimachia</i>	yes	yes	Eastern CAN and USA
<i>L. fraseri</i> Duby	<i>Lysimachia</i>	yes	yes	Southeast USA
<i>L. graminea</i> (Greene) Hand.-Maz.	<i>Seleucia</i>	yes	yes	Southeast USA
<i>L. hybrida</i> Michx.	<i>Seleucia</i>	yes	yes	CAN, USA
<i>L. japonica</i> Thunb.	<i>Lysimachia</i>	no	yes	Southeast USA
<i>L. lanceolata</i> Walter	<i>Seleucia</i>	yes	yes	Eastern CAN and USA
<i>L. lewisii</i> Estes, Shaw & Mausert-Mooney	<i>Seleucia</i>	yes	yes	Southeast USA
<i>L. loomisii</i> Torr.	<i>Lysimachia</i>	yes	yes	Southeast USA
<i>L. nummularia</i> L.	<i>Nummularia</i>	no	yes	CAN, USA
<i>L. × producta</i> (A. Gray) Fernald (pro sp.) [ <i>quadrifolia</i> × <i>terrestris</i> ]	<i>Lysimachia</i>	yes	yes	Eastern CAN and USA
<i>L. punctata</i> L.	<i>Lysimachia</i>	no	yes	CAN, USA
<i>L. quadriflora</i> Sims	<i>Seleucia</i>	yes	yes	Central CAN and USA
<i>L. × radfordii</i> H.E. Ahles [ <i>loomisii</i> × <i>quadrifolia</i> ]	<i>Lysimachia</i>	yes	yes	Southeast USA
<i>L. radicans</i> Hook.	<i>Seleucia</i>	yes	yes	Southern USA
<i>L. terrestris</i> (L.) Britton, Sterns & Poggenb.	<i>Lysimachia</i>	yes	yes	CAN, USA [not AK, YT, NT]
<i>L. thyrsiflora</i> L.	<i>Naumburgia</i>	yes	no	CAN, USA [including AK, YT, NT]
<i>L. tonsa</i> (Alph. Wood) Alph. Wood ex Pax & R. Knuth	<i>Seleucia</i>	yes	yes	Southeast USA
<i>L. vulgaris</i> L.	<i>Lysimachia</i>	no	yes	CAN, USA

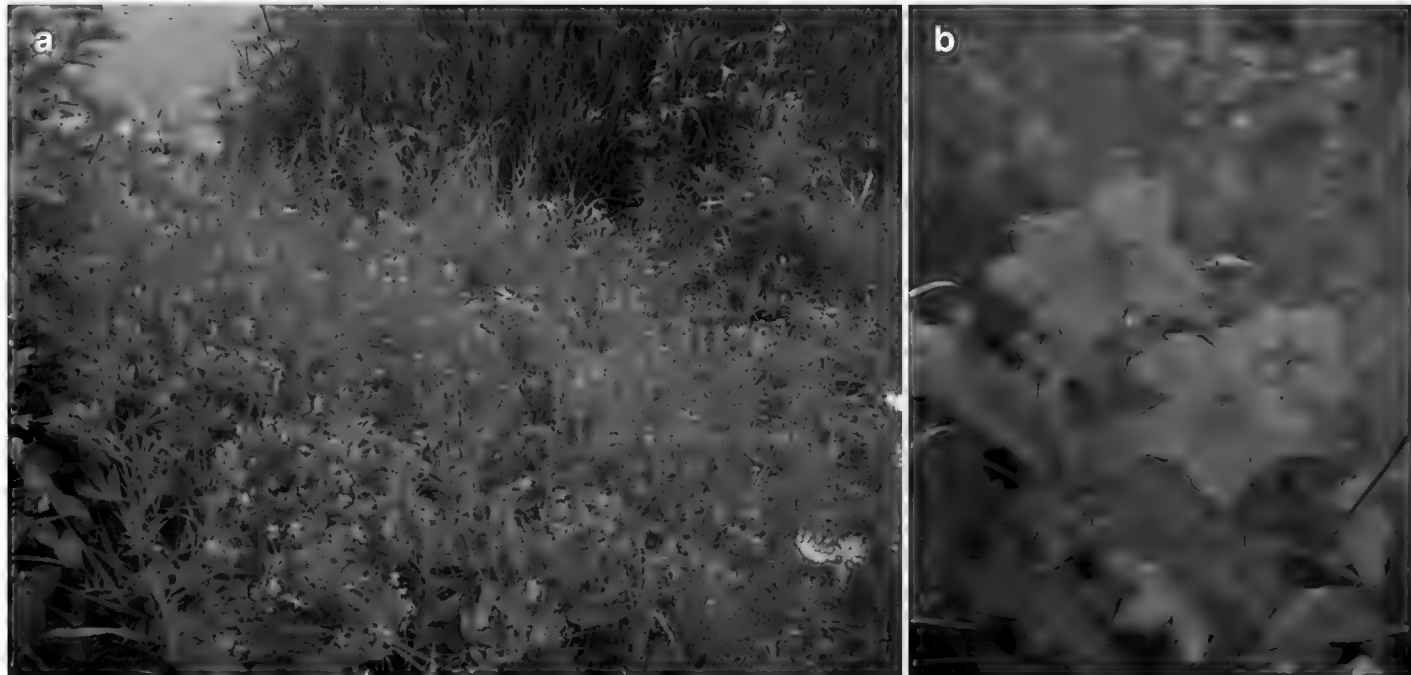


Figure 6.

*Lysimachia ciliata* L. (Primulaceae), a native oil-producing species.

**a:** Growing at river's edge, Speed River, Guelph Ontario. Photo by C. Sheffield. [doi](#)

**b:** Flowers up close. The central reddish areas are oil-producing glands. [doi](#)



Figure 7. [doi](#)

A non-native oil producing species, *Lysimachia punctata* L. (Primulaceae), growing as an ornamental in Guelph, Ontario. Photo by C. Sheffield.

Assessing the conservation status of cuckoo bees is challenging, particularly because these species are dependent on the presence of their host(s), are typically present in low abundance due to their specialised life histories and, therefore, are not as commonly collected as non-parasitic bees (Sheffield et al. 2013b). Additionally, the host(s) of very few cuckoo bees are known (Michener 2007, Sheffield et al. 2013b), so the threats to host(s) may be unknown. Most of the recently collected specimens of *E. pilosulus* have been captured through passive methods of sampling; specimens collected in 2002 in Nova

Scotia (Sheffield et al. 2004) and 2005-2006 in Connecticut (Wagner and Ascher 2008, Wagner et al. 2014) were from pan traps. While these traps are easily set, choosing the appropriate habitat can be challenging because little is known about the microhabitat characteristics of the cuckoo bee in North America, though somewhat known for the host (see Rozen and Jacobson 1980, Cane et al. 1983). *Macropis* bees are relatively widespread but uncommon, though potential host plants are also widely distributed (Fig. 5). Presence and abundance of *Lysimachia* are not strong indicators of the host bee's presence (COSEWIC 2011) and both are not uniformly distributed throughout the landscape. Therefore, it is also assumed these factors also limit the population of *E. pilosulus*.

In the past decade, interest in bee conservation has grown and sampling for bees has increased substantially, though much of this has been project specific and new records have been identified as part of larger studies (Sheffield et al. 2013a, Wagner et al. 2014), as opposed to efforts specifically targeting this species throughout its range (COSEWIC 2011). However comprehensive sampling for bees continues to be challenging and some cuckoo bee species can be rare within certain landscapes, have a limited flight period synchronised with the host(s) and/or may have population fluctuations, making their detection difficult (Sheffield et al. 2013b). However, for *E. pilosulus* and other cuckoos of oil bees (Alves-dos-Santos 2009), it may be possible to develop specific sampling methods to accurately assess the bee's presence in the landscape based on chemical ecology. For example, European species of *Macropis* and *E. coecutiens* (and likely its North American counter) find the flowers and nests of its *Macropis* hosts, respectively by the scent of floral oils (Dötterl and Schöffler 2006, Dötterl 2008), so developing a chemical lure for *E. pilosulus* in North America as a tool for conservation monitoring may be possible.

## Acknowledgements

We thank Paul Hebert from the Biodiversity Institute of Ontario, University of Guelph (Guelph, Ontario, Canada) for access to the specimen of *Epeoloides pilosulus* from Alberta, the late Charles Michener, University of Kansas (Lawrence, Kansas, USA), Andy Bennett, Canadian National Collection of Insects, Arachnids and Nematodes (Ottawa, Ontario, Canada), Steve Paiero, School of Environmental Sciences, University of Guelph (Guelph, ON), Jason Gibbs, University of Manitoba (Winnipeg, Manitoba, Canada) for sharing data from specimens from their respective institutions. Thanks to Jenny Wu (Environment and Climate Change Canada, Ottawa, Ontario, Canada) for mapping support, the Canadensys team (Canadian Network in Biodiversity Informatics, Centre sur la Biodiversité de l'Université de Montréal, Québec, Canada) for assistance with data sharing and Dave Fraser (British Columbia Ministry of Environment and Climate Change Strategy, Victoria, British Columbia, Canada) for support. Laurence Packer (York University, Toronto, Ontario, Canada) and Jakub Straka (Charles University, Prague, Czech Republic) provided critical comments on the manuscript.



## References

- Alves-dos-Santos I (2009) Cleptoparasite bees, with emphasis on the oilbees hosts. *Acta Biológica Colombiana* 14 (2): 107-114. URL: <http://ref.scielo.org/nfk9rs>
- Ascher J, Pickering J (2018) Discover Life bee species guide and world checklist. [http://www.discoverlife.org/mp/20q?guide=Apoidea\\_species&flags=HAS:](http://www.discoverlife.org/mp/20q?guide=Apoidea_species&flags=HAS:). Accessed on: 2018-3-08.
- Atlantic Conservation Data Centre (2017) Species Ranks. <http://www.accdc.com/en/ranks.html>. Accessed on: 2017-12-06.
- Bequaert J (1920) Hymenoptera collected near Boston, Mass., with description of a variety of *Bombus affinis*. *Psyche* 27 (1): 6-12. <https://doi.org/10.1155/1920/45767>
- Bogusch P (2005) Biology of the cleptoparasitic bee *Epeoloides coecutiens* (Hymenoptera: Apidae: Osirini). *Journal of the Kansas Entomological Society* 78 (1): 1-12. <https://doi.org/10.2317/0310.16.1>
- Cane JH, Eickwort GC, Wesley FR, Spielholz J (1983) Foraging, grooming and mate-seeking behaviors of *Macropis nuda* (Hymenoptera, Melittidae) and use of *Lysimachia ciliata* (Primulaceae) oils in larval provisions and cell linings. *American Midland Naturalist* 110 (2): 257-264. <https://doi.org/10.2307/2425267>
- Cardinal S, Straka J, Danforth BN (2010) Comprehensive phylogeny of apid bees reveals the evolutionary origins and antiquity of cleptoparasitism. *Proceedings of the National Academy of Sciences* 107 (37): 16207-16211. <https://doi.org/10.1073/pnas.1006299107>
- CESSC (2016) Wild Species 2015: The General Status of Species in Canada. Canadian Endangered Species Conservation Council, National General Status Working Group, 128 pp. URL: <https://www.wildspecies.ca/reports>
- Chen FH, Hu CM (1979) Taxonomic and phytogeographic studies on Chinese species of *Lysimachia*. *Acta Phytotaxonomica Sinica* 17: 21-53.
- Cody WJ (2000) *Flora of the Yukon Territory*. Second Edition. NRC Research Press, Ottawa, 669 pp. [ISBN 978-0-660-18110-3]
- Coffey VJ, Jones SB (1980) Biosystematics of *Lysimachia* section *Seleucia* (Primulaceae). *Brittonia* 32 (3): 309. <https://doi.org/10.2307/2806721>
- COSEWIC (2011) COSEWIC Assessment and Status Report on the Macropis Cuckoo Bee *Epeoloides pilosulus* in Canada. Committee of the Status of Endangered Wildlife in Canada, Ottawa. URL: [http://www.registrelep-sararegistry.gc.ca/document/default\\_e.cfm?documentID=2297](http://www.registrelep-sararegistry.gc.ca/document/default_e.cfm?documentID=2297)
- COSEWIC (2012) COSEWIC Assessment Process, Categories and Guidelines. [http://www.cosewic.gc.ca/94D0444D-369C-49ED-A586-EC00C3FEF69B/Assessment\\_process\\_and\\_criteria\\_e.pdf](http://www.cosewic.gc.ca/94D0444D-369C-49ED-A586-EC00C3FEF69B/Assessment_process_and_criteria_e.pdf). Accessed on: 2017-12-06.
- COSSARO (2010) COSSARO Candidate Species at Risk Evaluation Form for Macropis Cuckoo Bee (*Epeoloides pilosula*). Committee on the Status of Species at Risk in Ontario (COSSARO), Peterborough, 5 pp. URL: <http://www.ontla.on.ca/library/repository/mon/26004/317237.pdf>
- Cresson ET (1878) Descriptions of new North American Hymenoptera in the collection of the American Entomological Society. *Transactions of the American Entomological Society* 7: 61-136. <https://doi.org/10.2307/25076368>

- Dotterl S (2008) Antennal responses of an oligolectic bee and its cleptoparasite to plant volatiles. *Plant Signaling & Behavior* 3 (5): 296-297. <https://doi.org/10.4161/psb.3.5.5271>
- Dötterl S, Schöffler I (2006) Flower scent of floral oil-producing *Lysimachia punctata* as attractant for the oil-bee *Macropis fulvipes*. *Journal of Chemical Ecology* 33 (2): 441-445. <https://doi.org/10.1007/s10886-006-9237-2>
- Duche A (1909) Contributions à la connaissance des Hyménoptères des deux Amériques. *Revue d'Entomologie* 27: 28-55.
- Estes D, Shaw J, Mausert-Mooney C (2015) *Lysimachia lewisii* (Primulaceae): a new species from Tennessee and Alabama. *Phytoneuron* 17: 1-15.
- GBIF (2018) GBIF Occurrence Download. <https://doi.org/10.15468/dl.4mglnz>. Accessed on: 2018-3-31.
- Gibbs J, Ascher JS, Rightmyer MG, Isaacs R (2017) The bees of Michigan (Hymenoptera: Apoidea: Anthophila), with notes on distribution, taxonomy, pollination, and natural history. *Zootaxa* 4352 (1): 1-160. <https://doi.org/10.11646/zootaxa.4352.1.1>
- Kline B (2017) New bee family discovered in Kootenays. <http://www.castlegarnews.com/news/new-bee-family-discovered-in-kootenays>. Accessed on: 2017-9-04.
- Marr KL, Bohm BA (1997) A taxonomic revision of the endemic Hawaiian *Lysimachia* (Primulaceae) including three new species. *Pacific Science* 51 (3): 254-287.
- Master L, Faber-Langendoen D, Bittman R, Hammerson GA, Heidel B, Ramsay L, Snow K, Teucher A, Tomaino A (2012) NatureServe Conservation Status Assessments: Factors for Evaluating Species and Ecosystem Risk. NatureServe, Arlington, 64 pp. URL: [http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors\\_apr12\\_1.pdf](http://www.natureserve.org/sites/default/files/publications/files/natureserveconservationstatusfactors_apr12_1.pdf)
- Michener CD (2000) *The Bees of the World*. The Johns Hopkins University Press, Baltimore, 913 pp. [ISBN 0-8018-6133-0]
- Michener CD (2007) *The Bees of the World*. Second Edition. The Johns Hopkins University Press, Baltimore, 953 pp. [ISBN 13: 978-0-8018-8573-0]
- Michez D, Patiny S (2005) World revision of the oil-collecting bee genus *Macropis* Panzer, 1809 (Hymenoptera: Apoidea: Melittidae) with a description of a new species from Laos. *Annales de la Société entomologique de France (N.S.)* 41 (1): 15-28. <https://doi.org/10.1080/00379271.2005.10697439>
- Mitchell TB (1962) Bees of the eastern United States. Volume II. North Carolina Agricultural Experiment Station Technical Bulletin 152: 1-557.
- NSESA (2013) Species at Risk Overview. NS Endangered Species Act: Legally Listed Species. <https://novascotia.ca/natr/wildlife/biodiversity/species-list.asp>. Accessed on: 2018-3-09.
- Pekkarinen A, Berg O, Calabuig I, Janzon LA, Luig J (2003) Distribution and co-existence of the *Macropis* species and their cleptoparasite *Epeoloides coecutiens* (Fabr.) in NW Europe (Hymenoptera: Apoidea, Melittidae and Apidae). *Entomologica Fennica* 14 (1): 53-59.
- Popov VB (1958) Peculiar features of correlated evolution of two genera of bees—*Macropis* and *Epeoloides* (Hymenoptera, Apoidea)—and a plant genus *Lysimachia* (Primulaceae). *Entomological Review* 37: 499-519. [In Russian].
- Porsild AE, Cody WJ (1980) *Vascular Plants of Continental Northwest Territories, Canada*. National Museum of Natural Sciences, Ottawa, 667 pp. [ISBN 0-660-00119-5]

- Provancher L (1888) Additions et corrections au Volume II de la Faune Entomologique du Canada. Traitant des Hyménoptères. C. Darveau, Québec, 475 pp. [In French].
- Ray JD (1956) The genus *Lysimachia* in the new world. Illinois Biology Monographs 24: 1-160.
- Rozen JG, Jacobson NR (1980) Biology and immature stages of *Macropis nuda*, including comparisons to related bees (Apoidea, Melittidae). American Museum Novitates 2702: 1-11.
- Sheffield CS, Rigby SM, Smith RF, Kevan PG (2004) The rare cleptoparasitic bee *Epeoloides pilosula* (Hymenoptera: Apoidea: Apidae) discovered in Nova Scotia, Canada, with distributional notes. Journal of the Kansas Entomological Society 77 (3): 161-164. <https://doi.org/10.2317/0310.23.1>
- Sheffield CS, Kevan PG, Pindar A, Packer L (2013a) Bee (Hymenoptera: Apoidea) diversity within apple orchards and old fields in the Annapolis Valley, Nova Scotia, Canada. The Canadian Entomologist 145: 94-114. <https://doi.org/10.4039/tce.2012.89>
- Sheffield CS, Pindar A, Packer L, Kevan PG (2013b) The potential of cleptoparasitic bees as indicator taxa for assessing bee communities. Apidologie 44 (5): 501-510. <https://doi.org/10.1007/s13592-013-0200-2>
- Sheffield CS, Perron J (2014) Annotated catalogue of the bees described by Léon Provancher (Hymenoptera: Apoidea). The Canadian Entomologist 146 (02): 117-169. <https://doi.org/10.4039/tce.2013.64>
- Stephen WP, Bohart GE, Torchio PF (1969) The Biology and External Morphology of Bees with a Synopsis of the Genera of Northwestern America. Agricultural Experiment Station, Oregon State University, Corvallis, 140 pp.
- Straka J, Bogusch P (2007a) Phylogeny of the bees of the family Apidae based on larval characters with focus on the origin of cleptoparasitism (Hymenoptera: Apiformes). Systematic Entomology 32 (4): 700-711. <https://doi.org/10.1111/j.1365-3113.2007.00394.x>
- Straka J, Bogusch P (2007b) Description of immature stages of cleptoparasitic bees *Epeoloides coecutiens* and *Leiopodus trochantericus* (Hymenoptera: Apidae: Osirini, Protepeolini) with remarks to their unusual biology. Entomologica Fennica 18: 242-254.
- Swenk MH (1907) The bees of Nebraska. III. Entomological News 18: 293-300.
- Swenk MH (1912) Studies of North American bees I. Family Nomadidae. University Studies of the University of Nebraska 12 (1): 1-113.
- USDA (2017) The PLANTS Database. <http://plants.usda.gov>. Accessed on: 2017-3-14.
- Wagner DL, Ascher JS (2008) Rediscovery of *Epeoloides pilosula* (Cresson) (Hymenoptera: Apidae) in New England. Journal of the Kansas Entomological Society 81 (2): 81-83. <https://doi.org/10.2317/jkes-703.19.1>
- Wagner DL, Ascher JS, Bricker NK (2014) A transmission right-of-way as habitat for wild bees (Hymenoptera: Apoidea: Anthophila) in Connecticut. Annals of the Entomological Society of America 107 (6): 1110-1120. <https://doi.org/10.1603/AN14001>
- Zhang M, Shui Y, Chen W, Wei Z (2006) *Lysimachia gesnerioides* (Myrsinaceae), a new species from China and Vietnam. Annales Botanici Fennici 43: 317-319.
- Zhou J, Yu X, Deng Y, Yan H, Lin Z (2015) *Lysimachia huangsangensis* (Primulaceae), a new species from Hunan, China. PLOS ONE 10 (7): e0132713. <https://doi.org/10.1371/journal.pone.0132713>

## Supplementary materials

### Suppl. material 1: Specimens of *Macropis* bees from Canada used for map generation

**doi**

**Authors:** Cory S. Sheffield, Jennifer Heron

**Data type:** occurrences

**Brief description:** File contains occurrence data for *Macropis* bee (Hymenoptera: Melittidae) specimens from Canada.

**Filename:** Macropis Canada Data.xls - [Download file](#) (53.50 kb)

### Suppl. material 2: Occurrence data of *Lysimachia* species occurring in Canada and the United States. **doi**

**Authors:** GBIF.org

**Data type:** occurrence

**Brief description:** Download Information:

DOI: <https://doi.org/10.15468/dl.4mglnz> (may take some hours before being active)

Creation Date: Friday, 30 March 2018 22:42:31 o'clock GMT

Records included: 20723 records from 112 published datasets

Data size: 5.2 MB

Download format: DWCA

Filter used: Country: Canada or United States

TaxonKey: *Lysimachia* L.

**Filename:** Lysimachia occurrence Canada and USA.txt - [Download file](#) (20.55 MB)